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ABSTRACT

A computer-assisted, diagnostic assessment system (Level III) is described that has been implemented on an IBM 370/155 and is written in Coursewriter III, Version 3. The function of this system is to administer a series of 10 examinations to 64 first year medical students. The system fulfills the University of Illinois School of Medicine's assessment goals by providing a diagnostic, nongraded system which furnishes students with continuous feedback on their progress. Students have responded favorably to their Level III experience. They especially appreciate the immediacy of the feedback after each exam (printout) and the complete listing and reference information given for each uncorrected question. In addition to availability through Coursewriter systems, a version of Level III is being prepared for use on the PLATO IV computer system. (WCM)

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Level III - A Computer-Assisted Student Assessment System

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Introduction

This paper describes a computer-assisted, diagnostic assessment system (Level III) that has been implemented on an IBM 370/155 and is written in Coursewriter III, Version 3. The function of this system is to administer a series of 10 examinations to 64 first year medical students.

Background

When the University of Illinois, School of Basic Medical Sciences, Urbana-Champaign (SBMS-UC), opened in the Fall of 1971, faculty and local physicians had revised the conventional basic science curriculum to provide beginning medical students with the necessary skills and knowledge that would allow a student to enter a clinical training program for the M.D. degree after a period of only 10 months[1]. The SBMS-UC curriculum incorporates over 2,000 specific learning objectives in 12 basic science disciplines, and multiple learning experiences for each of the 360 self-study units[2]. As well, it incorporates multiple prescriptive and diagnostic evaluation instruments and the use of practicing physicians and their patients.

During the first three years, 80 first year students have participated in the program with 98% of that group successfully passing the University of Illinois first year comprehensive examination, and 84% passing the National Board Part I examination.

The Role of Student Assessment

In any independent, self-pacing, self-instructional program which is based on learning objectives, students should be provided with constant and immediate feedback on their performances. Therefore, evaluation of progress is built into the SBMS-UC curriculum in three areas: 1) self testing by the student via the pre- and post-test questions (Levels I and II) in each of the 360 learning units; 2) objective, cognitive assessment with a comprehensive examination (Level III) given on a computer after each of the 10 curriculum divisions (clinical problems); 3) an oral evaluation by a practicing physician (Level IV) of the student's ability to relate the basic sciences to the clinical problem.

Level III Philosophy and Objectives

The Level III examination is a cumulative examination covering all the basic science units included in a clinical problem. Currently, 12 basic science disciplines are included in the examinations; anatomy, behavioral science, biochemistry, embryology, genetics, histology, immunology, microbiology, neuroscience, pathology, pharmacology, and physiology. Each Level III examination includes approximately 180 questions and takes 4-5 hours for a student to complete. Each Level III question is based on instructional objectives which are included within each curriculum unit. The primary goal of the Level III student assessment procedure is to provide a meaningful learning experience for each student.

The objectives of the Level III assessment system are as follows:

A. The Level III is an instrument to improve learning, not to assign grades. During the administration of each exam, the student is recycled back to each incorrect response and is given additional opportunities to achieve the correct answer. The student should leave each question with a positive experience, i.e. the correct answer. In a few words, the exam should be informative and not punitive in nature.

B. Each Level III is based on instructional objectives which are included within each learning unit.

C. Each Level III provides periodic testing which motivates students by providing them with short-term goals toward which to work, by clarifying for students what learning outcomes are expected, and by providing them with feedback concerning their progress.

D. Each Level III directs student learning efforts toward the objectives being measured. For this reason, each Level III is devised to test achievements for a representative sample of objectives of each learning unit.

E. Each Level III is diagnostic because it reveals the learning weaknesses of individual students in each curriculum unit. This is provided by listing for the student on a printout what questions he has missed. Also, through a detailed item analysis the composite results will provide the School with precise information on curriculum deficiencies.

F. Each Level III provides immediate feedback, thus allowing students to assess their progress, and to take corrective action immediately. This feedback also provides their advisors a constant and up-to-date picture of each student's progress and deficiency.

Rationale for Computer-Assistance

Computer-Assisted Instruction (CAI) was turned to as a medium which could facilitate the desired flexibility and achieve the above-mentioned objectives. First of all, the interactive nature of CAI would facilitate

the attempt to provide a "teaching exam". It would also allow some form of tutoring feedback (dealing with specific questions during the examination) tailored to the responses made by the student. Examinations could be processed individually and scored automatically with summarized information printed out in a matter of minutes. The nature of this summary information could be designed at will to meet the diagnostic needs of both the student and his advisors.

Systems Hardware and Software

The computer program (named LEVEL3) which handles this process is written in Coursewriter III, Version 3, as implemented on an IBM 370/155 operated by the University of Illinois Medical Center in Chicago. Terminals are connected by means of acoustic couplers and a telephone tie line between the Urbana and Chicago campuses. For student interaction, three Hazeltine 2000 video-display terminals are used. For hard copy output, an IBM Communicating Mag Card terminal is used.

Student Use

Figure 1 summarizes the flow in LEVEL3 as seen by the student[3]. When the student first signs on to LEVEL3, he is presented with an explanation of the use of the program (scoring, skipping questions, erasing, etc.) and a list of clinical problem examinations from which to choose (Fig. 1,A). Having chosen an exam, he is presented with a choice of disciplines tested in that exam, along with the number of questions for each discipline (Fig. 1, B). The choice of a discipline branches the student to a linear block of questions. As the student moves through this block, the computer accepts and scores his answers without feedback. In addition to giving an answer which may be scored, the student may enter other responses which give him some control of the program (Fig. 1,C). Entering a blank answer allows the student to choose not to answer and receive a zero score on the question. Responding "skip" (Fig. 1,D) allows the student to skip over a question without it being scored and be returned to it after he has seen the remaining questions in the section. At the end of a discipline, the program gives the student his score for the discipline and allows him to review the questions that the student missed.

During this review, the student is given the opportunity to correct his errors. If he is successful, bonus points are added to his score (an incentive to correct errors); if not, the program holds him on the question coaching him toward the correct answer. He may also request the correct answer from the computer (Fig. 1,E). When the student finishes correcting a section, he is given his "raised score" and is allowed to choose another discipline. When the student finishes all of the disciplines, he signs off and receives a hard copy printout of his results within 30 minutes (Figure 2). This printout includes the student's scores and a listing (with textbook references) of all questions which he was unable to correct.

The student, upon receiving his exam printout, may check out a paper copy of the exam on a "secure basis" and use these as learning tools. Armed with the bottom half of the printout, the paper copy examination, and his textbooks the student should proceed to understand all the correct answers.

Figure 1 - Flow Chart of LEVEL3 Interaction

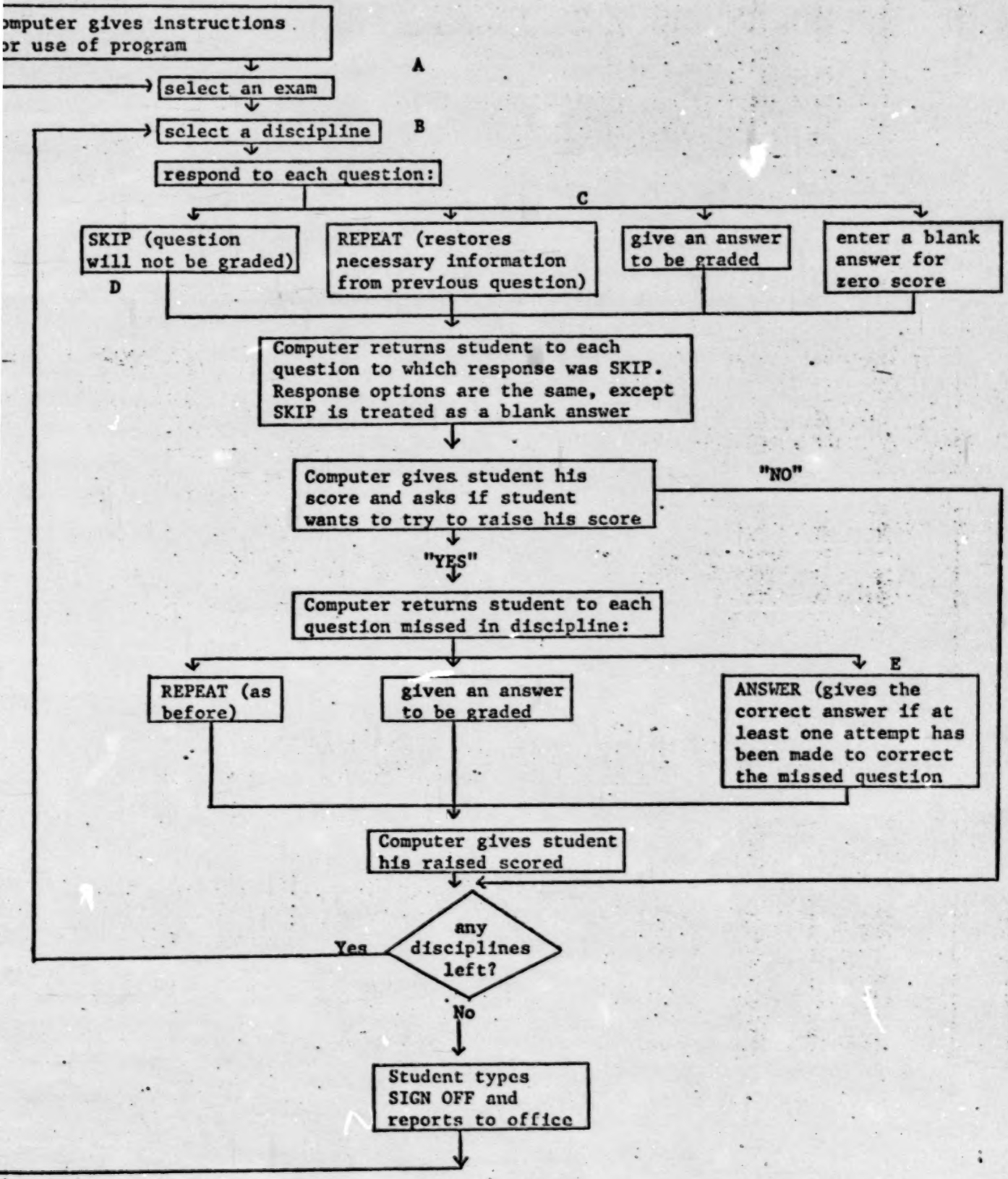
omputer gives instructions
or use of program
A
select an exam
select a discipline
B
respond to each question:
C
SKIP (question will not be graded)
D
REPEAT (restores necessary information from previous question)
give an answer to be graded
enter a blank answer for zero score
Computer returns student to each question to which response was SKIP. Response options are the same, except SKIP is treated as a blank answer
Computer gives student his score and asks if student wants to try to raise his score
"NO"
"YES"
Computer returns student to each question missed in discipline:
REPEAT (as before)
given an answer to be graded
E
ANSWER (gives the correct answer if at least one attempt has been made to correct the missed question
Computer gives student his raised scored
any disciplines left?
Yes
No
Student types SIGN OFF and reports to office

Figure 2 - Computer Printout

student's name:

examination: coronary heart disease running time of exam: 4 hr. 7 min.

section	# of questions	running mean	score	raised score
anatomy	14	+72.5	+72.2	+84.8
behav. sci.	4	-2.0	-30.0	+0.7
biochemistry	23	+73.7	+60.0	+73.0
embryology	0	+0.0	+0.0	+0.0
genetics	8	+56.3	+80.2	+86.1
histology	4	+61.0	+85.3	+85.3
immunology	7	+10.3	+95.3	+99.5
microbiology	0	+0.0	+0.0	+0.0
neuroscience	0	+0.0	+0.0	+0.0
pathology	21	+52.6	+55.8	+63.0
pharmacology	16	+54.9	+31.8	+47.1
physiology	44	+65.3	+66.0	+77.7
overall score	141	+59.0	+60.6	+72.0

questions which student was unable to correct:

section	curriculum unit #	question #	student answer given	textbook references
anatomy	15	2	bc	Grant, p. 478
anatomy	14	10	bc	Woodburne, p. 323
anatomy	14	6	abcde	P&H p. 274; Netter V, p. 253
behav. sci.	10	5	bcdef	Yalom 3-14
behav. sci.	10	7	d	Yalom 3-14
behav. sci.	10	6	a	Yalom 3-14
biochemistry	8	1	b	Lehninger, pp. 348-349
biochemistry	18	4	b	Lehninger, p. 182
biochemistry	12	9	c	Lehninger, p. 201
biochemistry	12	13	bcd	Lehninger, pp. 199-200
biochemistry	18	5	abcde	Lehninger, p. 383
biochemistry	17	6	eb	Lehninger, p. 517
biochemistry	12	2	abcde	Lehninger, p. 190
biochemistry	8	3	abcd	Lehninger, pp. 326,409,411
biochemistry	7	18		Lehninger, p. 570
genetics	11	6	acd	LM, pp. 743-749
genetics	17	4	bc	LM, p. 754 & Table 20-5
histology	22	1	ca	Ham, pp. 583-594
histology	22	2	acd	Ham, pp. 601,603
pathology	20	2	ab	R & A, pp. 201-202
pathology	21	8	bcde	R & A, pp. 182-184
pathology	23	9	adc	R & A, p. 249
pathology	40	14	cae	R & A, p. 527
pathology	40	15	a	R & A, p. 515
pathology	23	10	d	R & A pp, 246-247
pathology	19	17		R & A, p. 206
pathology	19	2	abd	R & A, p. 206
pathology	18	2	abcd	R & A, p. 152

Scoring of Questions

LEVEL3 is designed to allow a wide variety of multiple-choice type questions and to make the input of new questions and revision of old ones as simple as possible.

Each question may have any number of choices correct rather than the one choice correct per question format used on most standarized exams. The students are informed that one or more choices for each question may be correct, thus leaving it to the student to identify the proper combination of choices. The scoring system also allows for partial credit when the completely correct answer is a combination of the choices offered and the student identifies some but not all of them. Thus, each question is scored on a semi-continuous scale from -1 to +1 according to the following formula[4].

$$\frac{\#\text{ of student's choices correct}}{\#\text{ of possible correct choices}} - \frac{\#\text{ of student's choices wrong}}{\#\text{ of possible wrong choices}}$$

In a situation where all choices are correct, the second term of the formula is dropped and the scale of scoring is from 0 to +1.

Item Analysis

By allowing the student to enter all answers which he thinks are correct to an item, detailed performance data is provided on each specific response within each question. This question-performance data is then recycled back to the faculty and into the curriculum for modification of objectives or learning experiences.

Conclusion

The LEVEL3 computer-assisted program has fulfilled the School's assessment goals by providing a diagnostic, nongraded system which furnishes students continuous feedback on their progress. Students have responded favorably to their Level III experience throughout the year. They especially appreciate the immediacy of the feedback after each exam (printout) and the complete listing and reference information given for each uncorrected question. In addition to availability through Coursewriter systems, a version of LEVEL3 is being prepared for use on the PLATO IV computer system.

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4. Ibid.